## TITLE

## METHOD OF AND DEVICE FOR CONTROLLING AN ELEVATOR INSTALLATION WITH ZONAL CONTROL

## BACKGROUND OF THE INVENTION

The present invention relates to a method of and a device for controlling a elevator installation with several elevator cars in a building or the like, the floors of which are subdivided into several zones, wherein several travel orders are allocated to the elevator cars.

An elevator installation for zonal operation is shown in patent document EP 0 624 540. In the case of this elevator installation the traffic of persons between at least one main stopping point and zones in the high building is managed, with immediate allocation of zone calls, by an elevator installation consisting of three elevators. Each elevator user filling the building passes a portal which is associated with a zone in which a sensor registers the elevator user. Through selection of the corresponding portal the elevator user communicates his or her desired zone without manual actuation of a call registration device of the elevator control. The elevator cars travel in specific, fixedly associated zones. The zonal division serves the purpose of being able to fill a high building particularly quickly. For that purpose there are express elevators which travel past floors not served by these elevators.

On the same basis a zonal division is carried out also in the case of the elevator installation which is shown in the U.S. Patent No. 5,511,634. In that case, of the respectively free elevator cars there is allocated a new call to a new zone to that car which can serve this call most quickly.

An object of the present invention is to construct a method of and a device for controlling an elevator installation in such a manner that a zonal control can be carried out with separation of user groups associated with the zones whereby waiting times for individual user groups are minimized as much as possible.

## SUMMARY OF THE INVENTION

In the case of the control method according to the present invention the zones are preferably to be assigned to individual user groups with restricted access authorization.

By contrast to the previously described elevator installations and the controls thereof, in the case of the method according to the present invention a zonal operation serves for security purposes in order to strictly separate user groups from one another. If an elevator with a travel order assigned to a zone is busy, then further travel orders may be allocated thereto only from the same zone. The elevator car can be allocated to another zone only when it has finished all travel orders allocated thereto and thus is free. Before a call in accordance with a new travel order is allocated, in accordance with the present invention, however, firstly the number of free elevator cars is compared with the number of still unallocated, i.e. currently unserved, zones. It is thereby established whether still sufficient free elevator cars are present for all zones. This is then taken into consideration in the decision as to where to allocate the new call.

In a preferred embodiment of the present invention a call which is assigned to a zone already served by the elevator installation is allocated to a free elevator car only when a free elevator remains for each unserved zone. The calls are thereby so distributed to the individual zones of associated user groups that at least one elevator is always available for each group.

A particularly preferred form of embodiment solves problems which arise in the case of a physical separation of user groups on the basis of the access authorization thereof for a different elevator layout. Thus, there can be elevator installations in which some floors can be served only by a subgroup of elevators. If now specific user groups are assigned or to be assigned to these floors able to be served only in a restricted manner, substantially increased waiting times can in part occur with these or with the other user groups depending on travel destination, or the persons of other user groups can no longer be allocated.

According to the preferred embodiment this can be solved in that in the case of a new call it is established whether it is assigned to a zone which comprises at least one floor able to be served only in restricted manner. Such zones are here termed "favorite zones". Calls assigned to such a favorite zone are here termed "favorite calls". For the decision how a call is allocated it is preferably to be initially established whether it is a favorite call or not a favorite call, i.e. a non-favorite call. The allocation is then carried out in dependence on this determination.

In a further preferred embodiment such favorite calls are preferentially assigned to elevator cars which can serve all floors of a favorite zone. Such an elevator car is here termed "favorite car". In the case of allocation of a call it is preferably initially established whether or not the call is a favorite call, wherein for the allocation of favorite calls the number of free favorite cars is compared with the number of still unallocated favorite zones in order as far as possible to always be able to keep free one favorite car per unallocated favorite zone. In the case of a non-favorite call the number of non-favorite cars is compared with the still unallocated non-favorite zones in order as far as possible to always to be able to keep free one free non-favorite car per unallocated non-favorite zone.

In this manner, notwithstanding a heterogeneous elevator structure the individual user groups are handled uniformly and the waiting times for each specific user group are minimized. However, in the case of a correspondingly larger number of elevator cars to be allocated it is possible to react to an increased incidence of passengers in a user group.

It is thus also possible that several elevator cars are assigned to one zone. Then, also all elevator cars can be busy. If, however, an elevator car fails for whatever reason, then one of the user groups could thereby be disadvantaged if now an elevator was no longer available for its assigned zone.

For such a case it is provided in a preferred embodiment that when there are less free elevator cars than unserved zones, but one zone is served by several elevators, one of the elevator cars of these elevators serving these several zones is blocked for further orders. This car is then free after processing its orders and can be allocated to the unserved zone.

## DESCRIPTION OF THE DRAWINGS

The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

Fig. 1 is a diagram for clarification of a zonal control for elevator installations;

Fig. 2 is a schematic illustration of an elevator installation with several elevators and a heterogeneous elevator layout;

Fig. 3 is a schematic illustration of a first zone of the elevator installation shown in Fig. 2;

Fig. 4 is a schematic illustration of a second zone of the elevator installation shown in Fig. 2;

Fig. 5 is a schematic illustration of a third zone of the elevator installation shown in Fig. 2;

Fig. 6 is schematic illustration of an example of a call allocation to the elevator installation shown in Fig. 1;

Fig. 7 is a schematic illustration of an example of a call allocation as would be achieved by conventional controls proceeding from the situation shown in Fig. 6;

Figs. 8a through 8e are schematic illustrations of different call allocations and new calls, starting out from the situation illustrated in Fig. 6;

Fig. 9 is a flow chart for an algorithm in the control of an elevator installation, such as is illustrated by way of example in Figs. 2 to 5;

Fig. 10 is a part of the flow chart of Fig. 9 with reference numerals;

Figs. 11a through 11c are schematic illustrations of call allocations and new calls in the case of the elevator installation shown in Fig. 2, wherein Fig. 11a shows a start situation by way of example, Fig. 11b a new call in the case of the situation shown in Fig. 11a and Fig. 11c a call allocation, which would be obtained by a conventional control;

Fig. 12 is a part of the flow chart of Fig. 9 with reference numerals for illustration of how the control algorithm shown in Fig. 9 would perform the call allocation;

Fig. 13 is a schematic illustration of the final situation of the call allocation as is obtained by the algorithm shown in Fig. 9 starting out from the situation according to Fig. 11a;

Figs. 14 through 17 are further schematic illustrations of call allocation situations in the elevator installation according to Fig. 2 for clarification of the function of the control algorithm according to Fig. 9;

Figs. 18 and 19 are, by way of example, schematic illustrations of a call allocation without a free elevator car, for the purpose of explanation of a problematic situation;

Figs. 20 and 21 are schematic illustrations of call allocations corresponding to Figs. 18 and 19 for the purpose of illustration of a solution to this problem;

Figs. 22 through 24 are flow charts of an algorithm for solution of the problem illustrated in Figs. 18 and 19; and

Figs. 25 through 27 are schematic illustrations of different call situations, by way of example, for explanation of the function of the algorithm according to Figs. 22 through 24.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

**General observations**

### 1.1 Introduction to the problem of zonal control

A zonal control in buildings or the like (ships would also be conceivable) is used in order to separate different groups of elevator passengers from one another. The zonal control is a safety feature which is used in buildings or the like where passenger groups have to be separated from one another.

If there are, for example, two groups of passengers, namely a group "1" and a group "2", then in a zonally controlled building a passenger belonging to group "1" may not travel together with a passenger belonging to group "2".

In a zonally controlled building or the like every destination call is assigned to a zone. In order to separate passenger groups, an elevator which is busy may not accept any call assigned to a zone different from the zone which the elevator is just serving. It may be assumed, for example, that an elevator "A" serves a call for a zone "1". It may be further assumed that at this instant a passenger belonging to the group "2" registers a call. Due to the zonal separation the passenger from the group "2" may travel only in his or her zone "2", whilst the passenger from the group "1" may travel only in his or her zone "1". Accordingly this new call from the passenger belonging to group "2" cannot be assigned to the elevator "A".

In the case of the elevator installation present here as well as in the case of the control method fundamental here to such an elevator installation it shall be made possible to undertake a favorable control method with use of such a zonal control. The individual user groups respectively assigned to a zone shall be effectively separated from one another so that no person from a first user group can travel by an elevator serving a second zone.

The individual user groups can be assigned to the individual zones by known person identification measures. For this purpose the elevator installation can have different person identification devices. Examples are key switches, code buttons, electronic keys, chip cards, finger sensors, etc. Virtually any technology known in the sector of locking technology, such as, for example, in the case of doors, gates or motor vehicles, is usable. For example, a person belonging to a specific user group can register a call for a travel order with a destination floor in his or her zone only with use of a personal mechanical or electronic key or with input of his or her personal code. In the case of the corresponding control method there is thus preferably carried out, with the call input, a person identification in order to assign the call to a specific zone.

### 1.2 Change of zones

In a zonally controlled building either each elevator can serve actual calls or it has no orders. If the elevator does not have any travel orders, it is "free". In free state an elevator can accept a call from any zone.

If an elevator serves calls within one zone, the elevator cannot change the zone until it is free. An example with two zones is indicated in Fig. 1. In that case the meanings are:

**R → Z1** - a call assigned to the zone “1”

**Z1** - zone “1”

**Knj** - the elevator has no orders

**fr** - the elevator is free

**R → Z2** - a call is assigned to the zone “2”

**Z2** - zone “2”

Fig. 1 illustrates the above case.

## 2. Favorite car algorithms

In order to solve assignment problems in buildings with heterogeneous elevator layouts or heterogeneous elevator structures, so-called favorite car algorithms are used.

For illustration of the problem and the solution presented here, an elevator structure, by way of example, and some zones associated therewith are described in the following in the way that they can actually occur in specific buildings. All examples submitted with regard thereto are based on the zones and structures which have been

presented. After an introduction the algorithm proposed in accordance with the example of embodiment is explained together with some examples.

### 2.1 Elevator structure

An example of a heterogeneous elevator structure (elevator layout) is reproduced in Fig. 2. The elevator installation schematically illustrated there comprises six elevators with elevator cars **A**, **B**, **C**, **D**, **E** and **F**. A main entrance **ME** is indicated by a dashed line. The elevators with the cars **A**, **B**, **C** and **D** go from the main entrance **ME** only upwards. In the example presented here the elevators with the cars **E** and **F** also serve basement floors lying below the main entrance **ME**. Thus, only the elevator cars **E** and **F** serve all floors of the building. The following examples refer to this elevator structure by way of example, as is presented in Fig. 2.

### 2.2 Zones

The building illustrated here is a building in which a zonal control is desired as a safety feature. For this purpose it may be assumed that the building is a bank building which additionally has public areas - for example a floor in which eating facilities are provided - and living areas. In Figs. 3 through 5 the zones resulting therefrom and respectively to which individual user groups of the elevator installation are assigned are indicated in each instance by a shaded bar.

#### 2.2.1 Zone 1: Visitors

In the example present here the first user group shall concern visitors. The visitors shall, in the example illustrated here, have access to the main entrance and to a visitor floor. The visitor floor can be, for example, the floor with publicly accessible eating facilities or the visitor rooms of the bank. Zone "1" is illustrated by the reference numeral **Z1** in Fig. 3. There, a shaded bar is at the main entrance **ME** and a shaded bar at in the visitor floor.

The two further user groups for the example building are residents and bank staff.

The visitors have the following floors in common with the residents: main entrance **ME** and the visitor floor. The visitors have only the main entrance floor **ME** in common with the bank employees.

As apparent from Fig. 3, in the example illustrated here all elevators **A** through **F** serve the floors of the visitors and thus the zone **Z1**.

### 2.2.2 Zone 2: Residents

Residents of a building shall obviously have access to those floors on which their dwellings are located. Usually in the sub-floor of a building there are also regions which shall be accessible to a resident, such as basement areas or a residents underground garage.

In Fig. 4 a zone "2" by way of example - denoted by reference numeral **Z2** - is indicated for a resident. The floors for residents are, in the illustrated example, the main entrance **ME**, all floors from the visitor floor and thereabove and some floors below the main entrance.

The residents have the main entrance floor **ME** and the visitor floor in common with the visitors. The residents have only the floor "main entrance" **ME** in common with the bank employees.

### 2.2.3 Zone 3: Bank staff

In the example illustrated in Fig. 5 the floors for the bank employees are all floors from the main entrance **ME** up to the visitor floor (wherein the visitor floor is not included therewith) and some floors below the main entrance **ME**. The zone "3" resulting therefrom is characterized in Fig. 5 by **Z3**. The bank employees accordingly have only the floor "main entrance" **ME** in common with the visitors and the residents.

### 2.3 Definitions

Some expressions are explained for better understanding of the favorite car algorithms:

### 2.3.1 Favorite zone

A zone is a "favorite zone" if it contains floors which are not reachable by every elevator car. In the above examples the zones "residents" **Z2** and "bank staff" **Z3** are favorite zones.

### 2.3.2 Favorite car (favorite elevator)

An elevator car is a "favorite car" if it can serve all floors of at least one favorite zone. In the above examples the elevator cars **E** and **F** are favorite cars.

### 2.3.3 Favorite call

A call assigned to a travel order is a favorite call if it is assigned to a favorite zone. This can be established, for example, by known person identification measures as explained above. If a passenger is identified as a resident by a corresponding key or

code, then he or she can register a travel order to a destination floor within the zone **Z2**. The corresponding call is then assigned to the zone **Z2**. In the case of the example illustrated here the visitor does not necessarily have to have a person identification. The bank employees in turn need a key or the like for input of a call assigned to the zone **Z3**.

### 2.3.4 Number of unassigned favorite zones

The number of those favorite zones, which are not assigned at the time or in fact to any elevator or an elevator car, is termed number of non-assigned favorite cars. An example of that is reproduced in Fig. 6.

In that case the elevator cars **A, B, C** and **F** are free (this state is indicated in the drawings by the reference symbol **fr**). The elevators **D** and **E** are busy with travel orders. The elevator **D** serves a travel order of a visitor and thus is assigned to the zone **Z1**. The elevator **E** serves a travel order of a resident and is thus assigned to the zone **Z2**.

In this example the number of non-assigned favorite zones is one. The zone **Z3** is a favorite zone, but it is not assigned to any elevator car.

### 2.3.5 Number of non-assigned non-favorite zones

All zones which are not favorite zones are here termed non-favorite zones. The number of non-favorite zones which is actually or at the time not assigned to any elevator is termed the number of non-assigned non-favorite zones. In the example of Fig. 4 the number of non-assigned non-favorite zones is zero. The sole non-favorite zone in our example is the zone **Z1**. One elevator car, namely the elevator car **D**, is assigned to the zone **Z1**.

### 2.3.6 Sufficient favorite cars available

The condition "sufficient favorite cars available" is to be fulfilled when the number of free favorite cars is greater than or equal to the number of non-assigned favorite zones.

This condition or this expression is advantageous when a decision has to be taken whether or not a call is to be assigned to a free elevator car.

In the example of Fig. 7 the elevator cars **A** through **C** are free. The elevator car **D** is assigned to the zone **Z1** and the elevator cars **E** and **F** are assigned to the zone **Z2**. In this example insufficient elevator cars are available! The two favorite cars **E** and **F** are busy. A favorite car is no longer left for the favorite zone **Z3**.

### 2.3.7 Sufficient non-favorite cars available

The condition "sufficient non-favorite cars available" is fulfilled when the number of free non-favorite cars is greater than or equal to the number of non-assigned non-favorite zones.

This expression is advantageous when a decision has to be taken whether or not a new call shall be placed in a free elevator car.

### 2.4 Why an algorithm?

If a call is input by a user, the call is immediately assigned to a zone. According to known assignment algorithms - see for this purpose, for example, EP 0 301 178 - the elevator control then selects the best elevator car which can serve this call. This can be undertaken, for example, in dependence on a costs minimization or on algorithms for the quickest possible filling and/or for shortening of waiting times. For the selection of the best elevator car there are at that instant only a few restrictions: the elevator car must be able to serve not only the starting floor, but also the destination floor, the zone state of the elevator car must be "free" **fr** or the zone assigned at that time to the elevator car must correspond with the zone assigned to the call.

What can take place in that case is illustrated in Figs. 8a through 8c.

In Fig. 8a there is illustrated, by way of example, the starting state. This state corresponds with the state of Fig. 6, i.e. the elevator car **D** is assigned to the zone **Z1** and the elevator car **E** to the zone **Z2**, whilst the remaining elevator cars are free **fr**. In this state there is a new call **nRZ2** in zone **Z2**, as illustrated in Fig. 8b. This new call **nRZ2** is the requirement of a travel order between a residential floor and a basement floor accessible for residents.

The elevator control selects, for example, the elevator car **F** as the best elevator car.

The then-resulting allocation situation is reproduced in Fig. 8c. The state corresponds with that of Fig. 7, wherein the newly allocated call is shaded.

Without a special algorithm the following situation can now arise:

It may be assumed that a new call **nRZ3** is now indicated by a bank employee, who would like to go between the main entrance **ME** and the basement floor accessible only for bank staff. This new call belongs to the zone **Z3** and contains one of the basement floors.

As Fig. 8e shows, there is no available elevator car for this purpose. The free elevator cars **A** to **C** cannot serve the basement floor and the two favorite cars **E** and **F**, which could serve the basement floor, are assigned to another zone **Z2** and therefore may not be assigned to the zone **Z3**.

The bank employee therefore has to wait until one of the two elevator cars **E** and **F** is free again. Since also new destination calls from the zone **Z2** could always be input again here, this wait can in certain circumstances last for a very long time.

For a solution of such a problem an "allocation to a free car" algorithm is proposed. This analyses the situation and shifts the elevator allocation of the call belonging to the zone **Z2** to the elevator car **E** and not to the elevator car **F**.

After the algorithm has been performed, the call can be definitively assigned and information can be given to the user to indicate to him or her the allocated car for his call.

### 2.5 The "assignment to a free car" algorithm

The "assignment to a free car" algorithm is reproduced in Fig. 9 in the form of a flow chart. The flow chart is, with consideration of the following legends, self-explanatory:

**R = f** - Call is a favorite call. Here it is investigated whether or not the call is a favorite call.

**GfK** - Sufficient favorite cars available? This condition is investigated on the basis of the above definition. In that case the interrogation is (also) carried out in such a manner that it is investigated whether <u>after</u> an allocation of the new call to a free favorite car sufficient favorite cars are then still available.

**TbfK** - Take the best favorite car. The selection from the number of free favorite cars is carried out according to the criteria also used with customary control algorithms.

**AfKsZ** - Other favorite cars travel in the same zone. Here it is investigated whether there is already a favorite car which is assigned to the same zone to which the new call belongs.

**GnFK** - Sufficient non-favorite cars available? With the interrogation it is preferably also investigated whether after allocation of the new call to a free non-favorite car sufficient non-favorite cars are then still available.

**R → nfK** - Call can be shifted to a non-favorite car.

**AnfKsZ** - Other non-favorite cars travel in the same zone.

**TbfKsZ** - Take the best favorite car travelling in this zone.

**TbnkF** - Take the best non-favorite car.

**R → nfKsZ** - Call can be shifted to a non-favorite car travelling in this zone.

**TbnfKsZ** - Take the best non-favorite car travelling in this zone.

**nc** - No change.

**2.5.1 What would the algorithm do in the example of Figs. 8a through 8e?**

For this purpose reference is made to the decision branch, which is illustrated in Fig. 10, from the algorithm of Fig. 9. At **100** the condition "the call is a favorite call" has been found to be "true": The call illustrated in Fig. 8b belongs to the favorite zone **Z2** and is thus a favorite call.

If the call - as happens in our example by the upstream customary control algorithm - were to be placed with the elevator car **F**, sufficient elevator cars for a call in the favorite zone **Z3** would no longer be available. The condition "sufficient favorite cars available" gfK is thus not fulfilled, as is indicated by the reference numeral **102**.

On the other hand, the favorite car **E** already travels in the zone **Z2**. The condition "other favorite cars travel in the same zone" afKsZ is thus fulfilled, as is recognizable by the reference numeral **104**.

There are still three free non-favorite cars. The condition "sufficient non-favorite cars available" gnfk is thus fulfilled. However, the new call **nRZ2** of Fig. 8b cannot be allocated to any non-favorite car, since none of the non-favorite cars **A** to **D** can serve the basement floor contained in the new call **nRZ2**, which leads to the decision reproduced at **106**.

Thus, the algorithm leads to the statement **tbfKsZ**, i.e. the best non-favorite car travelling in this zone must be taken, as indicated at the reference numeral **108**. This is the correct decision, because now the new call **nRZ2** is allocated to the elevator car **E** and thus a favorite car **F** is kept free for the favorite zone **Z3**. The new call **nRZ3** of Fig. 8d can be allocated without undue waiting times.

**2.5.2 A further example**

Fig. 11a represents a further situation which can happen. In the case of Fig. 11a the elevators of the cars **A**, **B**, **D** and **E** are out of operation, which is indicated by the reference symbol **oos** (out of service). The elevator car **C** is assigned to the zone **Z2** and

the elevator car **F** is free **fr**. It may now be assumed, as illustrated in Fig. 11b, that a new call **NRZ2** is input in the zone **Z2**, which demands a travel order between the main entrance **ME** and an upper residential floor. Such an order, by way of example, can also not be dealt with by a non-favorite car **A** or **B**. Conventional elevator controls would assign such a new call **NRZ2** to, for example, the elevator car **F**, since it recognizes this as best elevator car.

Without an algorithm there would thus be the situation illustrated in Fig. 11c, according to which the elevator cars **C** and **F** are both assigned to the zone **Z2** and the remaining elevator cars are out of operation **oos**.

There is then the problem that a possible new call to be assigned to the zone **Z3** (see, for example, the call **nRZ3** from Fig. 8d) cannot be assigned particularly when this call can be served only by a favorite car.

In Fig. 12 it is shown what the algorithm illustrated in Fig. 9 would do in this case.

As indicated at **110**, the algorithm has decided that the call is assigned to the zone **Z2** and is thus a favorite call. The decision **112** is based on the fact that only one favorite car is left, but there are two favorite zones. If the call were to be assigned to the elevator car **F**, sufficient favorite cars would then no longer be available. This leads to the decision **112**.

At **114** it is to be noted that in the situation illustrated in Fig. 11a no car is left for the non-favorite zone **Z1**, since only a single non-favorite car **C** travels in the zone **Z2** and all other non-favorite cars are unavailable. This leads to the decision that insufficient non-favorite cars are available.

The non-favorite car **C** travels in zone **Z2**. There are thus still other non-favorite cars travelling in the same zone, as is indicated at **116**.

Since the new call **NRZ2** concerns only the floor main entrance **ME** and floors lying thereabove, the call can be allocated to a non-favorite car travelling in the same zone. The non-favorite car **C** travelling in the same zone can serve all floors in upward direction from the entrance. The corresponding decision is shown at **118**.

Thus the algorithm leads at **120** to the instruction **ZbnfKsZ** to take the best non-favorite car travelling in the same zone. This is, in the example of Fig. 11a, the car **C**!

The corresponding allocation undertaken on the basis of the algorithm is reproduced in Fig. 13. The algorithm shifts the call allocation of the call **NRZ2** from the elevator car **F** selected by upstream elevator algorithms to the elevator car **C**. The algorithm has kept free the elevator car **F** for further calls belonging to the zone **Z3**. A call belonging to the zone **Z3** can thus be served in every case.

Note: If, however, a new call cannot be moved to the zone **Z2** or the elevator car **C**, the algorithm would lead to the decision "no change" **nc**. The call would not be shifted at all. Then, according to the otherwise known algorithms, the elevator car **F** would be allocated to the call.

**2.5.3 Example One (1)**

Reference will be made to Fig. 14. As apparent therefrom, there is again the elevator layout according to the foregoing examples (Figs. 2 to 5) with six elevators **A** through **F**. There are two favorite cars of the elevator group, which are denoted by **E** and F. There are the following defined zones:

Zone **Z1** - non-favorite zone

Zone **Z2** - favorite zone for the cars **E**, **F**

Zone **Z3** - favorite zone for the cars **E**, **F**

The car **E** may be assigned to the zone **Z2**. The car **F** may be free. For a new call allocated to the zone **Z1**, a costs calculation algorithm would select, for example, car **F** for this call. If the car **F** were to be allocated to the zone **Z1**, however, no car would be left for the zone **Z3**.

The algorithm of Fig. 9 prevents this problem. As readily seen from the flow chart of Fig. 9, the algorithm decides in this example that the best non-favorite car, which already travels in this zone **Z1**, is to be taken for this new call for zone **Z1**.

**2.5.4 Example Two (2)**

Here reference is made to Fig. 15. As evident therefrom, there is again the elevator layout according to the foregoing examples (Figs. 2 to 5) with six elevators **A** through **F**. There are two elevator cars of the elevator group, which are denoted by **E** and **F**. There are the following defined zones:

Zone **Z1** - non-favorite zone

Zone **Z2** - favorite zone for the cars **E**, **F**

Zone **Z3** - favorite zone for the cars **E**, **F**

In this example it may be assumed that the car **A** is to be allocated to the zone **Z1** and the car **E** to the zone **Z2**. The remaining cars may be free **fr**.

If now the car **F** were to be allocated to the zone **Z1**, no favorite car would be left for the zone **Z3**. In order to avoid this problem, the algorithm decides - as readily seen from the flow chart of Fig. 9 - that the best non-favorite car must be taken for this new call.

**2.5.5 Example Three (3)**

The third example is illustrated in Fig. 16. There is here again six elevators, but three non-favorite cars **A** to **C** and three favorite cars **D** through **F**. As defined zones there may be assumed:

Zone **Z1** - non-favorite zone

Zone **Z2** - non-favorite zone

Zone **Z3** - favorite zone for the cars **D** through **F**

Zone Z4 - favorite zone for the cars **D** through **F**

In the case of the example according to Fig. 16 the cars **A** and **B** are assigned to the zone **Z1** and the cars **D** and **E** to the zone **Z3**. The cars **C** and **F** may be free. There is now a new call assigned to the zone **Z3**. A pure costs calculation algorithm would assign this new call to, for example, the elevator car **C**.

If, however, the elevator car were to be assigned to the zone **Z3**, no elevator car would remain for the zone **Z2**.

The decision of the algorithm can - as also in the case of the above Examples One and Two - be readily obtained from the flow chart of Fig. 9. As evident therefrom, the algorithm avoids the above-mentioned problem. The algorithm decides that the best favorite car, which already travels in the zone **Z3**, must be taken for this new call assigned to the zone **Z3**. The algorithm may not take the car **F**, because then a car would no longer be left for zone **Z4**.

**2.5.6 Example Four (4)**

Reference is made to Fig. 17 for the Example Four. Here an elevator layout as in Fig. 16 may be assumed. Accordingly, there are three favorite cars in an elevator group, which are denoted by **D**, **E** and **F**. Two of them may be assigned to the zone **Z2**. Overall the following zones may be defined here:

Zone **Z1** - non-favorite zone

Zone **Z2** - favorite zone for the cars **D** through **F**

Zone **Z3** - favorite zone for the cars **D** through **F**

The elevator cars **C** and **F** may be free. For a new call assigned to the zone **Z2** a costs calculation algorithm would select, for example, car **F** for this call.

If, however, the car **F** were to be assigned to the zone **Z2**, no favorite car would be left for zone **Z3**.

It is readily evident from the flow chart of Fig. 9 what the algorithm presented here does in this case. It *attempts* to place this call with the car **C** if this is possible, so as to keep a favorite car free for zone **Z3**. If this is not possible, the best favorite car, which travels in the zone **Z2**, *must* take the call.

**2.6 The "missing car for zone" algorithm**

Reference may now be made to a situation as illustrated in Fig. 18. Here again an elevator structure, by way of example, as evident from Fig. 2 is assumed. The subdivision of the individual floors of the building provided therewith takes place as explained above with respect to Figs. 3 to 5. In the case of the illustrated situation the cars **A**, **B**, **D** and **F** serve the zone **Z3**. The car **C** is assigned to the zone **Z1** and the car **E** is assigned to the zone **Z2**. Only a single car travels in the zone **Z1**. All other cars travel in other zones. No car is free.

It may now be further seen, as illustrated in Fig. 19, that the elevator car travelling in the zone **Z1** is unavailable. This is indicated by the reference symbol **oos** for "out of operation". In other words, the zone **Z1** is "lost". From now on, all persons who want to register a call assigned to the zone **Z1** can no longer be served.

At this instant an algorithm, which is termed "missing car for zone", begins to work:

The mode of operation is illustrated in Figs. 20 and 21. As is evident from Fig. 20, this algorithm determines from all travelling (i.e. non-free) cars a specific car which will no longer receive calls. This car - in the example, car **D** - is blocked against new calls. A car in such a state is here termed "jumper car" **SK**.

As illustrated in Fig. 21, a jumper car, as soon as it has processed all existing calls, is free and can then process calls for the zone that has become lost. In the final situation illustrated at the right in Fig. 21 the car **D** can now be used for the zone **Z1**. The "missing car for the zone" algorithm in this situation again stops working.

If more than one zone becomes "lost" in the above-described manner, this algorithm selects for each lost zone a jumper car which then jumps into the free state after processing its orders from the allocated zone.

Two lists are maintained by the "missing car for zone" algorithm: These are on the one hand a list for all favorite cars (favorite jumper cars) blocked against new orders and on the other hand a list for all non-favorite cars (non-favorite jumper cars) blocked against new orders.

An example of a "missing car for zone" algorithm is illustrated in Figs. 22, 23 and 24, wherein Fig. 22 illustrates the main part of the algorithm, Fig. 23 the process of maintaining of the list of non-favorite jumper cars and Fig. 24 the process of maintaining the list of favorite jumper cars.

The flow charts reproduced in Figs. 22 to 24 are self-explanatory with consideration of the legends set out below.

The "missing car for zone" algorithm illustrated therein is called up each time before a call is definitively assigned to a car.

Legends for the flow charts of Figs. 22 to 23:

**LSnfK** - Maintaining the list of non-favorite jumper cars;

**LSfK** - Maintaining the list of favorite jumper cars;

**KeLSnfK** – Car is in the list of non-favorite jumper cars;

**KeLSfK** - Car is in the list of favorite jumper cars;

**nc** - No change;

**tbuKsZ** - Take the best non-jumper car travelling in this zone (in other words, the algorithm blocks the jumper cars against a new call allocation);

**mnfZ** – Missing non-favorite zones;

**rLSnfK** - Reset the list of non-favorite jumper cars (the list of those non-favorite cars, which are blocked for new call allocations, is set to zero);

**K = fr** - Car is free;

**K = nf** - Car is non-favorite car;

**#mnfz > #SnfK** - The number of missing non-favorite zones is greater than the number of non-favorite jumper cars;

**KsZ > 1** - More than one car travels in this zone;

**K → LSnfK** - Add car to the list of non-favorite jumper cars;

**na** - No action;

**mfZ** - Missing favorite zones;

**rLSfK** - Reset the list of favorite jumper cars (the list of those cars blocked for a new call allocation is set to zero);

**K = f** - Car is favorite car;

**#mfz > #SfK** - The number of missing favorite zones is greater than the number of favorite jumper cars; and

**K → LSfK** - Add car to the list of favorite jumper cars.

### 2.6.1 Example

Reference may be made to Fig. 25, which shows a starting situation by way of example. In that case the elevator structure and the zone division may again be assumed to be such as explained in Figs. 2 to 5. There are accordingly the following defined zones:

Zone **Z1** - non-favorite zone

Zone **Z2** - favorite zone for the cars **E**, **F**

Zone **Z3** - favorite zone for the cars **E**, **F**

The allocation of the individual elevator cars **A** through **F** to these zones is apparent from Fig. 25.

The car C is now suddenly unavailable, which is indicated in Figs. 26 and 27 by "**UA**" (unavailable). In the case of the situation in Fig. 26 resulting therefrom future and waiting passengers, who are assigned to the zone **Z1**, can no longer be transported.

Now a new call is input. The call may be assigned to the zone **Z3**. A costs calculation algorithm would decide, for example, that the elevator car **D** is the best for this call.

It is readily apparent from the flow charts 22 to 24 what the "missing car for zone" algorithm would do in this case. This algorithm assigns the call not to the car **D**, but selects the car **D** as jumper car. The call is now assigned to the best of those other cars which already travel in zone **Z3**.

Later, as illustrated in Fig. 27, the car **D** is free **fr**. The car **D** is now free for an assignment to the zone **Z1**.

It is to be noted that the car **D** is now in fact kept free by the above-explained "assignment to free car" algorithm.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.